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ABSTRACT

To investigate the hypothesis that the process of curriculum development affects curriculum outcomes, three curricula for the same purpose were developed, each using a different approach. The task was to improve the mathematics curriculum at a college of electrical engineering in Zug (Switzerland). The task, which involved developing an introductory calculus course, met criteria previously defined for an acceptable context. The following curricular models were chosen: (1) a naturalistic model, as defined by D. F. Walker (1971); (2) the curriculum-conference approach of K. Frey (1980); and (3) the situational approach of S. B. Robinsohn (1967). Quantitative analysis of these curricula involved the rating of 17 subcategories by eight postgraduate students in mathematics and psychology to examine the main hypothesis of no differences among the curricula. The curricula differed in 10 of 17 categories, supporting the assumption that curriculum development models influence outcomes. Qualitative comparison by five experts in science and mathematics education also indicated differences in the developed curricula, with one expert placing more emphasis on practical application, another emphasizing the participation of the future engineer, and the third giving somewhat more attention to the subject matter than to the student. Two data tables are included. (SLD)

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Do Curriculum Development Models Really Influence the Curriculum?

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Introduction

It has long been the tacit assumption in the literature on curriculum that the model or models applied in development and planning influence the resulting curriculum, i. e. that the nature of the process affects the product.

Besides the actual development process other factors are agreed to contribute to the final curriculum and are thus taken into consideration, such as school organization, teacher socialization, the structure of the subject, economic conditions and so on. Very few authors nowadays question the tenet that the way in which a curriculum is developed is reflected in the curriculum itself. This is true of the authors of the so-called scientific curriculum-making period from Bobbitt (1934) and Charters (1923) to Taba (1962), as well as of the writings of Johnson (1967), Kliebard (1971), Schwab (1971) and Eisner (1979,1982) in North America, or of the European curriculum theorists such as Dahllöf (1970), Lundgren (1972), or Reid (1978). And it also applies to my own studies (Frey 1969, 1981). A number of studies bear evidence to the fact that codified curricula affect teachers and students' activities, as well as the outcomes of the teaching-learning process (Santini 1971; Harlen 1975; Duit, Riquarts, Westphal 1975). Textbooks, curriculum systems, syllabuses, guidelines, entrance examinations and computerized programs have also been shown to wield a certain degree of influence (Kulik et al. 1983; Stake et al. 1978).

In spite of this, true experimental studies testing the effects of the various developmental models on curricula are almost non-existent. Admittedly, there are dozens of reports and case studies dealing with one specific approach or model which provide an insight into curricular processes (Miles 1975). They generally show the advantages and the problems of specific approaches. But there are hardly any experimental studies attempting to refute the general assumption concerning the implications of the nature of curriculum processes. One of the few, and in fact the most elaborate example, is a quasi-experiment by Searles (1981), who took the three models conceived by MacDonald (1965) and applied them to existing textbooks.

Wishing to fill this gap we set ourselves the task of conducting an experiment in which we would try to disprove the hypothesis that the process of curriculum development affects outcomes. If the attempt failed, we would have to accept that the assumption did, after all, hold true. To this end we developed three curricula for the same purpose, each time using a different approach. This study only makes a contribution to the methodology in which the experiment (as such) plays a role. Our study is of no relevance for general theories such as those from Habermas (1971).

Methodological criteria for the experiment

Our initial task was to set up a methodological framework for a real experiment on curricular processes. We began by establishing a set of criteria to delimit an acceptable context. They read as follows:

1. At least two different appproaches must be included, whose nature of process is manifestly different, yet whose codification rules are not too programmed and implicative. If two curriculum development models are selected where, for

example, one prescribes that the curriculum should comprise a list of subject matter topics while the other stipulates a particular type of learning objective, including a quota of objectives in the affective domain, the comparison would yield no valid results.

2. The curriculum task should not be too open, i. e. classified and framed too low (Bernstein 1974). Arts, history or pre-school education as a designation of task would be insufficiently defined and differences in the resulting curricula would be inevitable.
3. Curriculum development cannot take place under laboratory conditions, nor can it be organized simply for experimental purposes. Should this be attempted, the deliberative processes lose their validity (cf. Gauthier 1966, Füglister 1978).
4. The institution cannot be an open one, nor may it have such variation potential as is found in general education at compulsory secondary schools. It should have a clear function: an appropriate choice would be, for example, a vocational school. The point of this criterion is to reduce the possibility that variance between the products of different curriculum models could be attributed to the variance or openness of the organization for which the curriculum is designed.
5. The subject matter elements involved in the curriculum process should be highly structured (classified and framed), such as certain areas of physics, chemistry or mathematics.

These five criteria impose such a degree of restriction that any differences practically have to be explained by the development models. The null hypothesis claims that curriculum development models do not affect the outcomes.

The experiment

A situation highly suited to our needs was provided when we were asked to improve, i. e. rewrite the mathematics curriculum at the school of electrical engineering in Zug, Switzerland. We were to develop an introductory calculus course, which fitted criterion no. 2 perfectly (highly classified and framed task area). The real situation was given (criterion no. 3) and the institution had a clear-cut function, the training of electrical engineers, which satisfied the criterion of institutional setting (no. 4). Moreover, the subject matter, calculus, did not give much scope for variation (criterion no. 5).

Thus we had ideal conditions for the kind of experiment we envisaged and could proceed. If differences were present in the curricula we produced, this could be assumed due to the development models themselves. In default of observable differences our null hypothesis would be proved.

In order to satisfy criterion no. 1 we chose the following three curriculum development models:

A. A naturalistic model as understood and described by Walker (1971).
B. The curriculum-conference approach as conceived of by Frey (1980): a deliberative group process based on a conspectus of the knowledge in the

field and the rules of rational communication (with characteristics similar to Schwab's practical).

C. The situational approach (Robinsohn 1967), proceeding from needs in real-life situations and developing from there qualifications required and to be acquired through school learning.

All these approaches are well described in literature, while the working conditions and procedures of the experiment itself as well as the quantitative and qualitative analysis of the results have been documented in such a way that they can be reproduced (Frei 1986).

Using the three approaches, three separate curricula were developed for the same task and the same school, each covering some 15 pages. The next step was to compare them. To achieve results that were as reliable as possible we made both a qualitative and a quantitative comparison.

Quantitative analysis

First we established five representative categories with relevance to the curricular field (cf. literature on curriculum and education e.g. Handbook of Research on Teaching, journals such as the Journal of Curriculum Studies or the European Handbuch der Curriculumforschung). These categories were then subdivided and made comprehensible, by means of description and examples, for anyone without a specialized knowlegde of curriculum theory. This yielded 17 subcategories, set out in Table 1.

Eight raters (postgraduate students in mathematics and psychology) rated on a three-point scale the representation of the 17 subcategories in each curriculum: (1) absent from the curriculum, (2) present in the curriculum, (3) well-represented in the curriculum.

We thus have a 3 (curricula) x 8 (raters) x 17 (subcategories) data cube with repeated measurement in case of raters. These ratings were checked for interater reliability (cf. Frei 1986 for details). A missing entry in Column I of Table 1 reveals that this reliability turned out to be insufficient in seven out of 51 cases (i.e. the standard deviation of these 8 raters values for one subcategory is not in the 95 % confidence interval of the theoretical standard deviation which is estimatet as mean of all 51 standard deviations). These cases were therefore excluded from the following analyses. The data cube is thus void for certain curricula in some subcategories.

The main hypothesis of no difference among curricula was evaluated by means of analysis of variance (repeated measurements design) with Curricula A, B and C as the three levels of the factor. Column III of Table 1 indicates in which subcategories the null hypothesis had to be rejected. Column II of Table 1 presents more detailed information on these differences, based on a posteriori Scheffé tests.

Table 1

The 17 subcategories, means and standard deviations (in parenthesis) for Curricula A, B and C, and results of the statistical analyses (for details see interpretation of columns)

		Columns I A	I B	I C	II	III
1	What is the aim of instructing differential and integral calculus ?					
1.1	Completion of a certain type of task	2.6 (.52)	2.4 (.52)	2.6 (.52)		
1.2	Understandig of technical literature	1.1 (.35)		2.4 (.52)	A<C	**
1.3	General background knowledge	2.4 (.52)	2.4 (.52)			
2	Which subject-matter elements are to be included?					
2.1	Elementary differential and integral calculus	2.5 (.53)	2.5 (.53)	2.8 (.46)		
2.2	Differential equations	2.6 (.52)	2.4 (.52)	3.0 (.0)		
2.3	Fourier and Laplace transformations	1.1 (.35)	1.9 (.35)	3.0 (.0)	A<B<C	**
2.4	Practical solution methods	1.9 (.35)		1.9 (.35)		
2.5	Specific applications in physics and technology	2.4 (.52)	2.8 (.46)	1.6 (.52)	C<(A,B)	**
3	How are students to encounter the subject matter?					
3.1	Prescription-type application		1.4 (.52)	2.4 (.52)	B<C	**
3.2	Exemplary case studies		2.9 (.35)			
3.3	In-depth development of context	1.3 (.46)	2.8 (.46)	1.3 (.46)	(A,C)<B	**

4	How are students to have mathematics knowledge at their disposal after the learning process?					
4.1	Understanding, classifying information	1.6 (.52)	2.8 (.46)	1.9 (.35)	(A,C)<B	**
4.2	Knowledge, insights	2.5 (.53)	2.3 (.46)	2.5 (.53)		
4.3	Thinking, making transfers	1.6 (.52)	2.6 (.52)		A<B	**
			Columns			
			I		II	III
		A	B	C		
5	How is the student to be activated/involved in the planning and study process?					
5.1	Participation in planning and instruction process	1.0 (.0)	2.6 (.52)	1.0 (.0)	(A,C)<B	**
5.2	Inclusion of students' own work experience	1.1 (.35)	3.0 (.0)	1.2 (.46)	(A,C)<B	**
5.3	Variety of activities	1.1 (.35)	2.1 (.35)	1.1 .35)	(A,C)<B	**

Interpretation of columns:

I : gives the arithmetic means and standard deviations for Crricula A, B and C. Missing entries indicate insufficient interater reliability.

II : gives type (subset) and direction of significant differences observed, e.g.

A<C : the respective subcategory is represented to a lesser degree in A as compared to C

(A,B)<C: no difference between A and B, but a significant difference of both A and B compared to C

III: gives significance level of overall differences (* = 5 %, ** = 1 %)

As we see from Table 1, curriculum B differs significantly from either one or both of the other two curricula in its more marked inclusion of the following categories:

2.3 Fourier and Laplace transformations

2.5 Specific applications in physics and technology

- 4.1 Understanding, classifying information
- 4.3 Thinking, making transfers
- 5.1 Participation in planning the instruction process
- 5.2 Inclusion of students' own work experience
- 5.3 Variety of activities

Curriculum C differs significantly from either or both of the other two curricula in its more marked inclusion of the following categories:

- 1.2 Understandig of technical literature
- 2.3 Fourier and Laplace transformations
- 3.1 Prescription-type application

Curriculum A occupies a middle position with no significant distinction through any specific category. Curriculum A displays the following similarities:

Similarity to Curriculum B

- 1.1 Completion of a certain type of task
- 1.3 General background knowledge
- 2.1 Elementary differential and integral calculus
- 2.2 Differential equations
- 2.5 Specific applications in physics and technology
- 4.2 Knowledge, insights

Similarity to Curriculum C

- 1.1 Completion of a certain type of task
- 2.1 Elementary differential and integral calculus
- 2.2 Differential equations
- 2.4 Practical solution methods
- 3.3 In-depth development of context
- 4.1 Understanding, classifying information
- 4.2 Knowledge, insights
- 5.1 Participation in planning and instruction process
- 5.2 Inclusion of students' own work experience
- 5.3 Variety of activities

Finally we tested whether the mean ratings for each curriculum correlate with those of the other curricula. Table 2 illustrates the results.

Table 2

Correlations between mean ratings of the three curricula

Curricula	Number of categories	Correlation coefficient	Probability	significant correlation
A and B	13	-0.11	0.72	no
A and C	13	0.58	0.04	yes
B and C	12	-0.48	0.11	no

From Table 2 it can be concluded that the pattern of Curriculum B differs significantly from the patterns of Curricula A and C. A negative correlation coefficient indicates a certain anti-parallelism between the curricula, i. e. a distinct representation of a subcategory in one curriculum is often associated with a slighter representation of the same subcategory in another curriculum.

In quantitative terms the results of the study are evident. Our null hypothesis statet that none of the curriculum models influence the outcomes, yet the curricula differ in 10 of 17 categories.

Thus we can continue to assume that curriculum development models influence the outcomes. This is all the more applicable to the usual types of curriculum process which have to do with school, language and related topics, and not with the specially functionalized and classified mathematics curriculum for a specific professional qualification.

Qualitative analysis

We cross-checked the results by means of a qualitative comparison, in which five experts in the field of science and mathematics education indepentently made a multifaceted comparative assessment on the aspects (a) curriculum structure, (b) the role of the student in the curriculum, (c) educational richness (e..g. teaching methods, sequencing of the curriculum) and (d) linkage to the students' future professional field.

The qualitative analysis yielded the following results for each curriculum:

For Curriculum B the point of departure and the point of refernce is the demand placed on the future engineer, who is required to introduce his/her own problems from the everyday work situation and thus participates more actively in the process of instruction.

In Curriculum C the problems of practice are the main determining factors. With its use of wide-ranging material it places more emphasis on practical application than on the mathematical basis.

Curriculum A, which structurally lies somewhere between the two others, though it has more affinity with Curriculum C than with Curriculum B, is more traditional in structure, with greater orientation to the subject matter than to the student.

Conclusion

Neither the quantitative nor qualitative results obtained under the stringent conditions of our experiment proved the hypothesis that the type of curriculum development process adopted carries no implications for the ensuing curriculum. The significance of the study lies in the fact that it was the first real experiment attempting to test the assumption, which had been tacitly accepted for decades, that the models applied in development influence the resulting curriculum.

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